Patentanwälte
KLEIN, PINTER
& LAMINGER OEG
Prinz Eugen-Straße 70
A-1040 Wien

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(71) Applicant
**Atlas Fahrzeugtechnik GmbH (FR Germany), Eggenpfad 26, 5980 Werdohl, Federal Republic of Germany**

(72) Inventors
**Albert Stubs**
**Rudiger Schroder**

(74) Agent and/or Address for Service
**Marks & Clerk, 57–60 Lincoln's Inn Fields, London WC2A 3LS**

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# (54) Control apparatus for an engine test stand

(57) A test-stand control apparatus permits the measurement of dynamic characteristic curves in a reproducible manner on a stationary test stand. The apparatus includes an engine rotational speed setter 105–122 a throttle valve setter 5–22 and/or a torque setter (not shown). A clock generator 3 delivers a clock pulse sequence divided by reducer stage 1 at a rate set by an operator. The output of stage 1 acts upon address counters 5, 105 which count off an address line. Address stores 8, 108 connected to the address counters 5, 105 comprise digital setting values for indicating a characteristic curve. The values called up from the address stores 8, 108 act upon D/A converters 11, 111 whose output signals represent the nominal signals for the rotational speed figure and the throttle valve figures respectively. Recorder 58 records the set values and the braking moment of the engine 51.

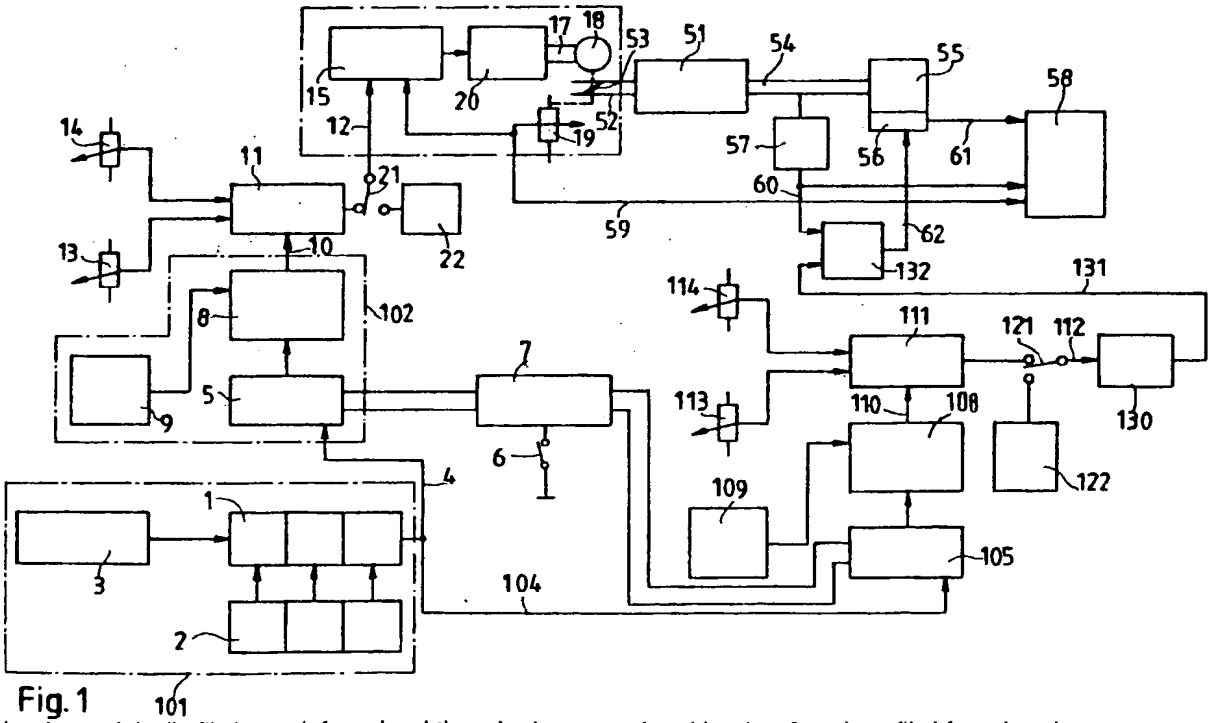


Fig. 1

The drawings originally filed were informal and the print here reproduced is taken from later filed formal copies.

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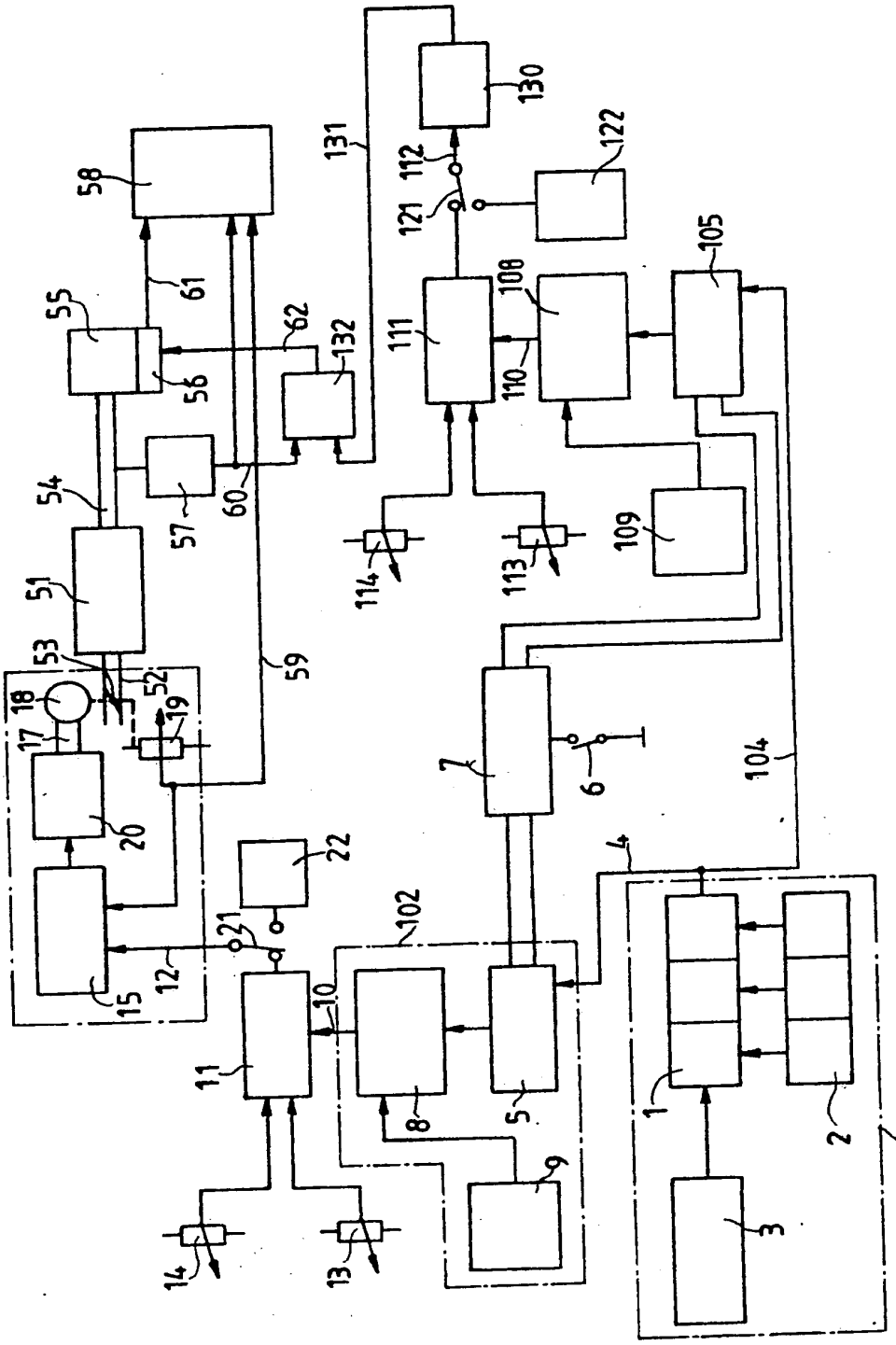


Fig.1

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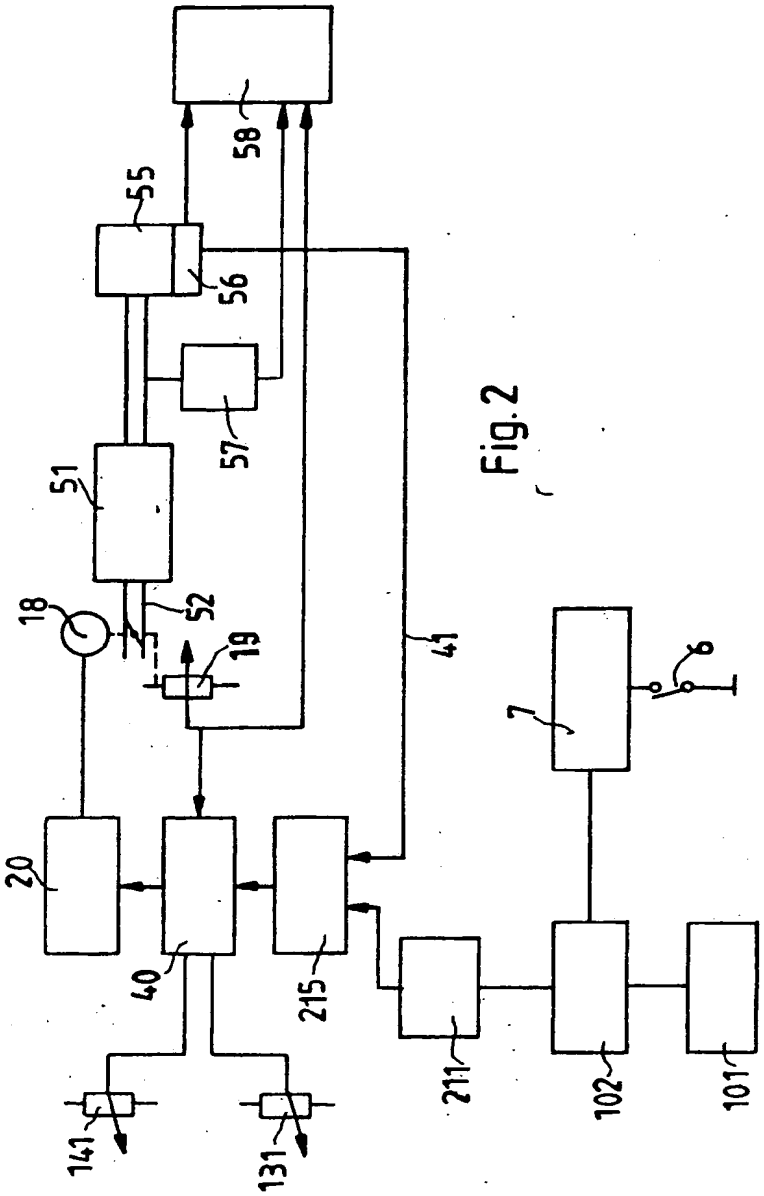


Fig.2

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SPECIFICATION

## Test-stand control apparatus for an engine test stand

This invention relates to a test-stand control apparatus for investigating dynamic processes on a stationary engine test stand having a setting stage for a rotational speed setter, a throttle valve setter and/or a torque setter.

It is not possible to test dynamic processes on a stationary engine test stand completely since the crankshaft is directly connected to a brake without inert masses and dynamic members being interposed as in normal operation. On the other hand, investigation on a rolle-type test stand is very costly.

The object of the invention is to provide a test-stand control apparatus which permits the measurement of dynamic characteristic curves on a stationary test stand in a reproducible manner.

This object is attained according to the invention by test stand control apparatus which comprises:

a) a clock generator which delivers a clock pulse sequence;

b) a reducer stage which can be set by a plurality of tens digits to generate an address counting pulse squence by pulse division of the clock pulse sequence;

c) an address counter acted upon by the address counting pulse sequence acts upon an address counter to count off an address line;

d) an address store connected to the address counter and having digital setting values for indicating a characteristic curve in at least one address line; and

e) a D/A converter actuated by the values called up from the address store act upon the output signal which represents the nominal signal for the rotational speed figure, the throttle valve figure and/or the torque figure.

The invention differs from the state of the art in a manner which is not obvious in that the setting and the adjustment of the test-stand parameters are predetermined by digital counting values and storage values. The time scale and also the interval for the change values can be adjusted as desired inside a wide range, so that the characteristic curves can be traversed in different ways. Characteristic curves of any desired shape can be kept available for reproducing operating states. In particular, operating characteristic curves of an engine obtained on a roller-type test stand can be reproduced on a stationary test stand and in this connexion changes in the operating behaviour can be studied. Specific measurement cycles on a stationary test stand can also be reproduced.

In order to detect different characteristic curves which are stored in an address store, the invention provides that a change-over stage is provided for the address store in order to select different address lines. Three bits can be allocated to the change-over stage, so that altogether 8 address lines can be selected inside the address store. Each address line comprises 256 addresses or memory locations. This ensures a high resolution.

In order that a plurality of address lines or characteristic curves can be stored and called up, the invention provides that a change-over stage is provided for the address store in order to select different address lines.

In order that the characteristic curves can be traversed in different directions, the invention provides that a direction-changing stage is provided for setting the counting direction of the address counter.

In addition, the invention provides that the address counting pulse sequence generator comprising the clock generator and the settable reducer stages is present singly or plurally for the rotational speed control circuit, the throttle valve control circuit and/or the torque control circuit.

In order that the adjustment range can be changed at will, the invention provides that an initial value setting stage and a final value setting stage are associated with the D/A converter. In this way the characteristic curves can be spread at will.

For the throttle valve setting it is arranged that the nominal signal for the throttle valve setter acts upon a comparator stage in which the actual signal for the throttle valve setter is compared with the nominal value.

For the rotational speed setting, the invention provides that the nominal signal for the rotational speed setter is supplied to a rotational speed regulating circuit.

In order to measure torque characteristic curves and in order to load the engine with constant torque the invention provides that the torque control circuit comprises an address counting pulse sequence generator, a performance graph store, a D/A converter, a comparator circuit and a limiter stage, the output signal of which controls a setting amplifier for the throttle valve adjustment, and the actual signal of the torque is fed on a line back to the comparator.

In order to eliminate overloading of the engine while measuring a torque characteristic curve, the invention provides that a minimum value setting stage and a maximum value setting stage are associated with the limiter.

Characteristic curves for constant throttle valve setting or constant rotational speed can be measured in that in each control circuit a fixed value setting stage for rotational speed setting, throttle valve setting and/or torque is provided together with a change-over switch in the line.

Embodiments of the invention are explained below with reference to the accompanying drawings, in which:

*Figure 1* shows a test-stand control apparatus according to the invention, and

*Figure 2* shows an embodiment of the invention for reproducing torque characteristic curves.

The stationary engine test stand receives an internal combustion engine 51, of which are shown an induction port 52 with a throttle valve 53 and the crankshaft or output shaft 54. The output shaft 54 is connected to a brake 55 which can be acted upon with a specific braking moment by way of a shifting stage 56. A rotational speed measuring means 57 measures the rotational speed of the output shaft 54. A sensor 19 emits values for setting the throttle valve 53. The measurement values for setting the throttle valve, the rotational speed and the braking moment are held in a recording apparatus 58.

As shown in Fig. 1 the test-stand control apparatus comprises circuits for the throttle valve setting. An address counting pulse sequence generator 101 comprises a reducer stage 1 with three tens digits, a setting circuit 2 for setting the reducer stage to the desired reduction factor or summoning value and a clock generator 3, whose clock pulses, which are emitted in a constant sequence, are divided in the reducer stage 1. The divided clock pulses at the output of the reducer stage reach an address counter 5 as an address counting pulse sequence by way of a line 4. The counting state of the address counter 5 is transmitted by the pulses to the line 4, so that an address line is continuously counted off. In the embodiment illustrated one address line comprises 256 addresses. A switch 6 is used for connecting an operating period of the test-stand control apparatus. A settable change-over stage 7 establishes the connexion and counting direction of the address counter 5. In this way, therefore, the direction in which the address line is traversed is predetermined.

Downstream of the address counter 5 there is connected an address store 8, the store addresses of which are called up in each case through the value indicated in the address counter 5. The address store 8 can contain memory locations in a plurality of address lines each of which represents a plurality of characteristic curves. A characteristic-curve change-over switch 9 is used to the characteristic curve change-over switch 9 as a whole form a performance graph store 102.

The output signals of the said performance graph store are converted in a D/A converter 11 into an analog signal which on the line 12 represents the nominal value for the throttle valve setting. Setting potentiometers 13 and 14 cooperate with the D/A converter 11. The initial value for the throttle valve setting can be fixed with the setting potentiometer 13, and the final value of the throttle valve setting can be fixed with the setting potentiometer 14. These setting potentiometers affect the D/A converter in such a way that the range of the characteristic curve is distributed between the setting values. In this way a spreading or extension of the characteristic curve is possible. The line 12 contains a change-over switch 21, by means of which the line 12 can be connected to the D/A converter on the one hand and to a setting stage 22 on the other hand. A fixed value for the throttle valve setting can be set in the setting stage 22.

The nominal value on the line 12 acts upon a comparator stage 15. The difference signal of the comparator 15 is amplified in an amplifier 20 and is passed on by way of an output line 17 to a throttle valve setter 18 in order to set the throttle valve 53 of the engine 51. The actual value of the setting of the throttle valve 53 is detected by a sensor 19 and is fed back to the comparator 15. A complete control loop is thus available for the throttle valve setting. The respective setting of the throttle valve is passed on as an actual signal on the line 59 to the recording apparatus 58.

The rotational speed setter is largely designed in the same way, so that the individual modules are indicated in each case by reference numerals increased by 100. The address counting pulse sequence generator 101 makes available on the line 104 the address counting pulse sequence for the rotational speed setter as well. This address counting pulse sequence actuates an address counter 105. The latter is in turn connected to the change-over stage 7, so that the rotational speed setter is controlled parallel to the throttle valve setter by way of the switch 6 and the change-over stage 7. The output signals of the address counter act upon an address store 108 which is connected to a characteristic curve change-over switch 109. On the line 110 the digital performance graph signals are fed into a D/A converter 111. The output line 112 comprises a change-over switch 121 which makes possible a change over to a setting stage 122 by means of which the rotational speed can be set to a fixed value. Setting potentiometers 113 and 114 permit a change in the inclination of the characteristic curve.

The rotational speed signals on the line 131 reach, by way of a buffer stage 130, a comparator 132 which compares the nominal signal on the line 131 with the actual signal of the rotational speed measuring device 57, which is present on the line 60. Depending upon the comparison a control signal is emitted on the line 62 for the switching stage 56 in order to set the braking moment inside the brake 55. The setting value of the switching stage 56 is applied to the recording apparatus 58 by way of the line 61.

In the address stores 8 and 108 characteristic curves are input in each case for the throttle valve setting and the rotational speed respectively. The characteristic curves are div-

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ided into 256 steps timewise. With a resolution of 256 stages a setting of the throttle valve or the rotational speed can be associated digitally with each step, so that any curves of the throttle valve position or the rotational speed setting can be traversed in 256 time steps. In this way any operating conditions of the engine can be simulated in a reproducible manner on a stationary test stand. These curves can be determined on a roller-type test stand for example. Standardized test cycles are also possible. The measurement values are recorded in the recording apparatus 58 in each case. In this way changes in the behaviour of the engine can be determined. In particular the effects of structural changes and changes in other setting magnitudes of the engine can be determined.

The reducer stage 1 permits the time scale to be extended or shortened, so that the individual characteristic curves can be traversed in a predetermined time. If the reducer 1 embraces three tens units, the time scale can be varied within a range between 1 and 1000. The setting potentiometers 13 and 14 or 113 and 114 respectively permit the initial and end points of each characteristic curve to be determined. This allows the characteristic curves to be extended or spread. The changeover stage 7 or 107 respectively makes it possible to traverse the stored characteristic curves forwards or backwards. It is possible, of course, to traverse a characteristic curve in an increasing and in a decreasing direction in mutual succession. It is also possible to fix in each case the throttle valve setting or the rotational speed value in a setting stage 22 or 122 respectively and to determine in each case the change in the engine behaviour, in particular the torque curve, as intended by the variation in the other engine size.

In accordance with a further embodiment of the invention according to Fig. 2 it is also possible to pre-set the torque. This circuit comprises the address counter pulse sequence generator 101 according to Fig. 1, a performance graph store 102 and a D/A converter 111. The performance graph store 102 is controlled by a switch 6 by way of a changeover stage 7. The output signal of the D/A converter 211 is an analog signal for the torque. This acts upon a comparator 215 to which is added on a line 41 the actual value of the torque determined in the shifting stage 56. The difference signal formed in the comparator 215 is added to an amplifier 20 for the throttle valve setter 18 by way of a limiter 40. The limiter 40 cooperates with setting potentiometers 131 and 141 which fix the final values of the throttle valve setting. It is possible by means of this circuit according to Fig. 2 to predetermine a torque characteristic curve or a fixed value for the torque.

## CLAIMS

1. A test-stand control apparatus for investigating dynamic processes on a stationary engine test stand having a setting stage for a rotational speed setter, a throttle valve setter and/or a torque setter, comprising:

(a) a clock generator (3) for delivering a clock pulse sequence;

(b) a reducer stage which can be set by a plurality of tens digits to generate an address counting pulse sequence by pulse division of the clock pulse sequence;

(c) an address counter actuated by the address counting pulse sequence to count off an address line;

(d) an address store connected to the address counter and comprising digital setting values for indicating a characteristic curve in at least one address line; and

(e) a D/A converter actuated by the values called up from the address store and the output signal of which represents the nominal signal for the rotational speed figure, the throttle valve figure and/or the torque figure.

2. A test-stand control apparatus according to Claim 1, characterized by a change-over stage for the address store in order to select different address lines.

3. A test-stand control apparatus according to Claim 1 or 2, characterized by a direction-changing stage for setting the counting direction of the address counter.

4. A test-stand control apparatus according to any of Claims 1 to 3, characterized in that the address counting pulse sequence generator comprising the clock generator and the settable reducer stage is present singly or plurally for the rotational speed control circuit, the throttle valve control circuit and/or the torque control circuit.

5. A test-stand control apparatus according to any of Claims 1 to 4, characterized in that an initial value setting stage and a final value setting stage are associated with the D/A converter.

6. A test-stand control apparatus according to any of Claims 1 to 5, characterized in that the nominal signal for the throttle valve setter acts upon a comparator stage in which the actual signal for the throttle valve setter is compared with the nominal value.

7. A test-stand control apparatus according to any of Claims 1 to 6, characterized in that the nominal signal for the rotational speed value is supplied to a rotational speed regulating circuit.

8. A test-stand control apparatus according to any of Claims 1 to 4, characterized in that the torque control circuit comprises an address counting pulse sequence generator, a performance graph store, a D/A converter, a comparator circuit and a limiter stage, the output signal of which controls a setting amplifier for the throttle valve adjustment, and the actual signal of the torque is fed back to the comparator circuit.

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9. A test-stand control apparatus according to Claim 8, characterized in that a minimum value setting stage and a maximum value setting stage are associated with the limiter.

10. A test-stand control apparatus according to Claim 9, characterized in that in each control circuit there is a fixed valve setting stage for rotational speed setting, throttle valve setting and / or torque together with a change-over switch.

11. A test-stand control apparatus substantially as herinbefore described with reference to the accompanying drawings.

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